The Commercial Geoduck Clam Fishery in British Columbia, 1976 to 1981

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June, 1983

Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 1712

Canadian Manuscript Report of Fisheries and Aquatic Sciences

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CANADIAN MANUSCRIPT REPORT OF FISHERIES

and

AQUATIC SCIENCES NO. 1712

THE COMMERCIAL GEODUCK CLAM FISHERY IN BRITISH COLUMBIA, 1976 to 1981

by

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June, 1983

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c) Minister of Supply and Services Canada 1983
Cat. No. FS 97-4/1712 ISSN0706-6473

correct citation for this publication:

Harbo, R.M. and S. D. Peacock. 1983. The commercial geoduck clam fishery in British Columbia, 1976 to 1981. Can. MS Rep. Fish. Aquat. Sci. 1712: vii + 40p.

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ABSTRACT

R. M. Harbo and S. D. Peacock, 1983. The commercial geoduck clam fishery in British Columbia, 1976 to 1981. Can. Man. Rep. Fish. Aquatic Sci. 1712:vii + 40p

Geoduck clams are harvested commercially by divers using hand-held high pressure water jets, guided and controlled underwater by a diver, to displace the substrate surrounding individual clams.

The commercial geoduck fishery in British Columbia began in 1976 with five boats harvesting 97 thousand pounds (44 metric tons) from the Strait of Georgia. The fishery expanded rapidly until 1979 when entry was limited and harvest quotas were established at 4.5 million pounds (2042 t) for the South Coast district, and 3.5 million pounds (1588 t) for the North Coast. The 1979 harvest by 72 boats was 5.4 million pounds (2450 t), taken from the Strait of Georgia and the West Coast of Vancouver Island.

In 1980 quotas were set totalling 5 million pounds (2269 t) for the South Coast district, and 3. 5 million pounds (1588 t) for the North Coast district. A total of 6.2 million pounds (2813 t) were harvested by 63 boats. Geoducks were harvested from the North Coast district for the first time in 1980, 149,999 pounds (68 t), and it is expected that the fishery in this area will expand in 1981.

The landed value of geoducks in British Columbia increased from $74,383 in 1977 to $2.26 million in 1980.

Geoduck licences for 1981 were restricted to previous licence holders landing more than 30,000 pounds (13.6 t) in the 1978 or 1979 seasons, including January 1st to March 31, 1980. This action reduced the number of licence holders to 52, a significant reduction from the 101 licence holders of 1979.

Key Words: geoducks, clams, shellfish, British Columbia, commercial fishing

RESUMÉ

R. M. Harbo and S. D. Peacock, 1983. The commercial geoduck fishery in British Columbia, 1976 to 1981. Can. Man. Rep. Fish. Aquatic. Sci. 1712:vii + 40p

Les geoducks sont recueillis à des fins commerciales par des plongeurs qui utilisent des jets d'eau à haute pression pour déplacer le substrat entourand chaque clam.

La pêche commerciale du geoduck a débuté en Colombie-Britannique en 1976, année où cinq bateaux en ont recueilli 97 000 livres (44 tonnes métriques) dans le détroit de Georgie. La pêche s'est rapidement développée jusqu'en 1979, puis l'accès en a été restreint et des contingents d' exploitation, soit 4,5 millions de livres (2 042 t.) dans le district de la côte sud et 3,5 millions de livres (1 588 t.) dans celui de la côte nord, ont été établis. En 1979, 72 bateaux ont recueilli 5,4 millions de livres (2 450 t.) dans le détroit de Georgie et sur la côte ouest de l'île Vancouver.

En 1980, les contingents on été fixés à 5 millions de livres (2 269 t.) et à 3,5 millions de livres (1 588 t.) pour les districts de la côte sud et de la côte nort respectivement. Au total, 6,2 millions de livres (2 813 t.) ont été pêchés par 63 bateaux. Pratiquee pour la première fois en 1980, la pêche des geoducks sur la côte nord a donné 149 999 livres (68 t.) et l'on s'attend à ce qu'elle se développe en 1981.

La valeur de geoducks débarqués en Colombie-Britannique est passée de $74,383 en 1977 a $2,26 millions en 1980.

Seuls les détenteurs de permis qui avaient débarqué plus de 30 000 livres (13,6 t.) de geoducks au cours des saisons 1978 or 1979 ainsi que du 1er janvier au 31 mars 1980 ont obtenu un permis de pêche en 1981. Le nombre de détenteirs de permis est ainsi passé de 101 en 1979 à 52.

Mots-cles: geoducks, clams, mollusques, Colombie-Britannique, pêche commerciale

INTRODUCTION

The geoduck, *Panope generosa* (Gould 1950) is the largest subtidal clam in British Columbia. The average weight of commercially harvested geoducks is 1.2 kg with reported weights up to 4.5 kg (Goodwin 1976). They are found subtidally to depths of 60 m. The body of the geoduck is buried up to a depth of 1.3 m in sand-mud, gravel and broken shell substrates, with the siphons extending to the surface of the substrate.

Although geoducks are found from Alaska to the Gulf of California (Quayle 1970), only Washington in the United States and British Columbia currently have commercial fisheries. The first fishery was in Washington in 1970, and it was not until 1976 that divers began harvesting in B.C. Recreational fishing and Native Indian food fisheries for this clam are minor.

Commercial diving fishermen concentrate their harvesting in high density clam beds. Geoducks tend to be found in aggregations as high as 38 m^2 (Harbo and Adkins, unpublished data) with average densities of unfished populations of 15 geoducks per m^2. (Breen and Shields, in press). Maximum densities observed to date occur subtidally at depths from 10 to 20 m.

GEODUCK BIOLOGY

Geoducks are filter feeders, straining out plankton by circulating water through their gills. Water is circulated through the long siphon (neck), which extends up to the surface of the substrate. Unlike many other clams, the geoduck cannot withdraw the siphon fully into its shell (Figure 1). The siphons, inhalent and exhalent, are fused forming a muscular tube to 1 m long. The siphon tip, called a "show" by fishermen, is the only visible part when the clam is buried in the substrate (Figure 2).

The ability of divers to detect geoduck siphons varies greatly depending on the season of the year (Goodwin 1977). In spring and summer months, the clams are actively pumping water and their siphons are easily seen by divers. In the winter, and at other times such as after storms or large tidal changes reduced pumping and retracted siphons make detection difficult.

The white shells, to 190 mm long are equal in size, oblong and rounded at anterior end and truncated at the posterior (Figure 3). The shells gape widely except at the hinge.

Geoducks from Ladysmith and Bamfield, British Columbia, aged by an acetate peel method show that geoducks grow rapidly in their first 8 to 10 years reaching a weight of 1.5 lb. or 0.7 kg (P. Breen, Pacific Biological Station, personal communications). After 10 years growth slows markedly, Geoducks live to be very old; for example, the geoducks sampled at Ladysmith had a mean age of 50 years and a maximum age of 140 years.

The reproductive biology and recruitment rates of geoduck populations are poorly understood. Unexploited geoduck populations are apparently mature stable populations, with very low recruitment and mortality rates. Studies are being conducted to determine recruitment rates in natural undisturbed areas and in heavily exploited locations.

Geoduck clams appear to have separate sexes without sex reversal as exhibited by some other molluscs (Goodwin 1976). Spawning in Washington State occurs in the spring, March to July (Goodwin 1976; Anderson 1971).

Further discussions of geoduck life history are available in Anderson (1971), Cox (1979), Cox and Charman (1979) and Goodwin (1973, 1976).

GEODUCK STOCKS

In 1977 the British Columbia Provincial Government, Marine Resources Branch, Ministry of Environment conducted a survey of the abundance and distribution of the geoduck clam in Queen Charlotte, Johnstone and Georgia Straits (Cox and Charman 1979). Marine Resources Branch also conducted geoduck surveys of portions of the Strait of Georgia and the west coast of Vancouver Island in 1978 and with the Department of Fisheries and Oceans in 1980 (unpublished data). Large areas of the north coast and on the west coast of Vancouver Island have not been surveyed.

Surveys were initially intended only to establish the extent of economically harvestable geoduck stocks in British Columbia. However, they have been used as estimates of geoduck standing stocks. Table 1 presents standing stock estimates partially from these Marine Resources Branch surveys and from estimates based on fishing patterns and harvest log data. These estimates are very preliminary and are intended to indicate densities that may be commercial in depths from 0 to 60 feet. There are likely considerable stocks in deeper water. This initial estimate of commercial geoduck populations is 254 million pounds or 115 thousand tonnes of geoducks.

Goodwin (1978) reported results on all the geoduck surveys in Puget Sound from 1967 to March 1977. His conservative estimate in Washington State was 33,799 acres with 117,653,000 geoducks. This represents approximately 306 million pounds or 130 thousand tonnes assuming an average whole wet weight of 2.6 lb. or 1.1 kg.

GEODUCK HARVEST METHODS

Geoducks are harvested commercially by divers using hand-held high pressure water jets, guided and controlled under water by a diver, to displace the substrate surrounding the geoducks. Divers normally wear dry suits, sometimes with full face masks, and obtain air through a hose from a compressor on the support vessel.

When a geoduck is sighted the diver exposes the tip of the siphon with the water jet, and then grasps the siphon while he continues to wash away the substrate around the geoduck until it is freed (Figure 4). The geoduck is placed in the diver's collection bag and he moves on to the next geoduck. The water jet is supplied with water from a surface water pump through a "layflat" hose to 60 m long.

The diver normally starts away from the boat extending the hoses and taking advantage of currents to carry away the siltation. When his bag is full he exchanges it for an empty one attached to a line on the boat. The full bag is hauled to the surface as the diver continues underwater. The diver support vessels, in B.C., have varied in size from 12 foot skiffs up to 70 foot boats.

DESCRIPTION OF THE GEODUCK FISHERY 1976 to 1980

Landings are reported by Fisheries Statistical Areas, North and South Coast regions as illustrated in Figure 5.

1976 GEODUCK FISHERY - STRAIT OF GEORGIA

In July, 1976 seven geoduck harvest permits were issued for areas in the Strait of Georgia, B.C. American geoduck divers assisted in the harvest, and trained Canadian divers. Harvesting permits granted exclusive harvesting rights by area. This prevented the harvesting from being concentrated in one area, and the catch data served as useful information on stock distribution. The geoduck and horse clam permit stipulated that all harvesting was to be conducted from bottoms deeper than 10 feet below chart datum. Each water nozzle was to have a maximum inside diameter of 5/8 inch and the nozzle was to have a shut off valve capable of being operated from full flow to completely off within one-half turn. This was intended to minimize the disruption of the substrate. No other harvest restrictions were in effect, and five operators harvested 97,000 pounds (44 t). The monthly catch by statistical area is given in Table 2.

The successful geoduck harvest in 1976 confirmed that the geoduck resource could support a commercial fishery.

1977 GEODUCK FISHERY - STRAIT OF GEORGIA, WEST COAST OF VANCOUVER ISLAND

The 1977 geoduck fishery operated again on a special permit basis until July 1st, 1977 when licences were required. An amendment to the Pacific Shellfish Regulations, Section 13(4) required that "No person shall use any mechanical digger, apparatus or dredge for the purpose of taking any species of clams except under a licence." Section 13(5) requires that "No person fishing under a licence referred to in subsection (4) shall fish except in the manner and in the area or areas specified in the licence".

Licences were issued to companies or individuals owning or leasing vessels with a current valid Commercial Fishing Licence. Each licence holder had to ensure that geoduck sales slips were forwarded weekly to the Department of Fisheries and Oceans, and that detailed harvest logs and maps were submitted for each diver. Although 30 licences were issued, only 14 vessels reported landings.

As in 1976, provisions were made for licence holders to obtain the services of American divers as diver trainers, for a maximum of 90 days between June 1st and September 30, 1977.

The season was open for all of 1977, without quotas, and the catch increased to 541,000 pounds (254 t). Most harvesting was conducted in the Strait of Georgia with a small catch, 13,000 pounds (5.9 t) from the Tofino region, Area 24 (Figure 5). The catch by month for each statistical area in 1977 is given in Table 3.

1978 GEODUCK FISHERY - STRAIT OF GEORGIA, WEST COAST OF VANCOUVER ISLAND

The geoduck fishery expanded strongly in 1978. Although 54 licences were issued, only 27 licences reported landings. The fishery was again open all year, without quotas, and the total recorded harvest was 2.2 million pounds (998 t). Most of the catch was taken from the Strait of Georgia, 1.7 million pounds (771 t). The catch on the west coast of Vancouver Island increased to 535,000 (243 t), landed by six vessels. The catch by month for each statistical area in 1978 is outlined in Table 4.

1979 GEODUCK FISHERY - STRAIT OF GEORGIA, WEST COAST OF VANCOUVER ISLAND

In 1979, the fishery continued to expand and the number of geoduck licences issued increased to 101. There was concern that the resource could not support harvests at the level anticipated for 1979 on an annual sustained yield basis. Considerably more information was required on the status of stocks and on spawning success and recruitment.

To ensure the geoduck fishery would remain viable, effective June 13, 1979, no further geoduck licences were issued. In addition, licences became nontransferable from one individual or company to another.

It was also announced in late 1979 that geoduck licences for 1980 would be restricted to licence holders landing more than 30,000 pounds (13.6 t) in 1978 or 1979. Separate licences were issued for harvesting in the North Coast region, Statistical Areas 1 to 10 (Figure 5). Of the 101 licence holders, only 72 landed geoducks in 1979.

For the first time, quotas were set as an additional management step. A coastwide quota of 8 million pounds was announced, a 3.5 million pound quota for the North Coast, Statistical Areas 1 to 10, and 4.5 million pounds for the South Coast Areas 11 to 27. Quotas were determined by an evaluation of patterns of fishing effort, landings, surveys and expectations of geoduck stocks.

Due to heavy exploitation in the Strait of Georgia, Areas 13 to 19, and Tofino, Clayoquot Sound, Area 24, these areas were closed on September 29, 1979 for the balance of the season. Other areas remained open for the balance of the season.

Table 6 outlines the catch by month for each statistical area in 1979. Approximately half of the total 1979 harvest of 5.4 million pounds (2,450 t) was taken from the west coast of Vancouver Island, primarily from Tofino, Area 24. The remaining 2.7 million pounds (1,255 t) was harvested from areas in the Strait of Georgia. There were not any reported landings from the North Coast Region, Statistical Areas 1 to 10, in 1979.

1980 GEODUCK FISHERY - STRAIT OF GEORGIA, WEST COAST OF VANCOUVER ISLAND, NORTH COAST REGION

The quotas for the 1980 geoduck fishery were 5 million pounds (2,269 t) for the South Coast region, Statistical Areas 11 to 29 and 3.5 million pounds (1,588 t) for the North Coast Areas 1 to 10. The South Coast region was divided into management units, each with a separate quota, to facilitate area by area management (Table 7). Landings were monitored and as the quotas were met during the season, areas were closed individually by Fisheries Public Notices and Notices to Industry that advised processors of the closures.

Table 8 details the catch by month, for each statistical area in 1980. The total British Columbia harvest in 1980 was approximately 6.8 million pounds (2,813 t). This was harvested by only 63 boats of 95 licences issued. The South Coast catch, Areas 11 to 27, totalled 6.04 million pounds (2,471 t). The catch from the Strait of Georgia decreased to 2.17 million pounds (985 t) while the fishery on the west coast of Vancouver Island continued to increase with landings totalling 3.88 million pounds (1,760 t). The overrun on the South Coast quota of 5 million pounds was caused by the lag time between the actual harvest and the reporting of the catch. In 1980, areas in the South Coast were closed by August 31. (Table 7).

The geoduck fishery expanded to the North Coast region in 1980. A harvest of 150,000 lb (68 t) was recorded from seven vessels fishing in Statistical Areas 2E, 4, 9 and 10 (Table 8).

LANDED VALUES OF GEODUCKS, 1977 to 1980

The landed value (the price paid to the fishermen) of geoducks in British Columbia increased from $89,393 in 1977 to $2.79 million in 1980 (Table 9). This large increase reflects an increase in landings and prices paid per pound. The mean price per pound increased from $0.17 in 1977 to $0.37 in 1980. Prices ranged in 1980 from $0.30 to $0.48 per pound (B.C. Catch Statistics Annual Reports).

SUMMARY OF THE DEVELOPMENT OF THE GEODUCK FISHERY

LICENCING REGULATIONS AND MANAGEMENT PRACTICES

The history of the regulations relating to the geoduck fishery, and the pattern of change in the geoduck fleet size are summarized in Table 10. The introduction of licence limitation in 1979 checked the rapid increase in the number of vessels licenced for the geoduck fishery. The minimum landing requirement reduced the fleet by 1980 to those vessels actively participating in the fishery. This was considered an essential step to maintain an economically viable geoduck fishery.

THE DISTRIBUTION OF LANDINGS BY STATISTICAL AREAS

A summary of the geoduck landings by statistical areas from 1976 to 1980 are outlined in Table 11. Table 12 contains geoduck landings by statistical areas expressed as a percentage of the annual landings. Landings and effort shifted considerably as the fishery developed.

The 1976 geoduck fishery was conducted entirely in the Strait of Georgia. The first harvest from the west coast of Vancouver Island was landed in 1977, and the percentage of the total geoduck harvest taken from these waters was increased each year to the 1980 level of 63 percent of the total catch in British Columbia (Table 12). There were corresponding decreases in landings from the Strait of Georgia.

A small harvest, 150,000 pounds (68 t), only 2.4 percent of the coastwide landings was taken from the North Coast region in 1980 but it is anticipated that the fishery in this region will expand in 1981. The limiting factors in the development of the North Coast fishery are the time and costs of transporting the geoducks from the grounds to the processing plants, the lack of support facilities (fuel, food, accommodation) and the problems associated with operating in the more severe physical environment of the North Coast.

HARVEST RATES

Up to and including 1978 there were no major shifts in effort and landings between areas throughout the year (Tables 2, 3, 4). Landings were consistently lower, however, during fall and winter months, October to March when geoducks were less active and did not "show". Poor weather would also have been a factor over that period.

In 1979 there was a significantly greater monthly harvest rate in Area 24, twice that of the peak harvests in areas in the Strait of Georgia (Table 6). When areas 13 to 10 and 24 closed to geoduck fishing on September 20th, 1979, exploration and effort shifted to the west coast of Vancouver Island, Areas 23, 25 and 26. Table 6 shows a marked increase in landings in these areas which remained open to December 31, 1979.

The harvest pattern changed dramatically in 1980 when management by Statistical Areas, quotas and closures were instituted, as shown in Table 7. There was a greater concentration of the fleet in given areas, and the collection and delivery of geoducks to the processors was improved. Unlike previous years, in 1980 there were great shifts of effort in the South Coast between areas. Monthly landings reached all time peaks, averaging one million pounds during the period March to June, 1980 (Table 8). Landings in Area 24 were three times that of any other area. However, landings were determined by quotas set according to stock estimates for those areas.

When the South Coast Areas 11 to 27 closed August 31, 1980, seven vessels moved their operations to the North Coast.

SUMMARIES OF SOME CATCH AND EFFORT STATISTICS FROM 1978 to 1980 CATCH STATISTICS

The data presented in this section are reported landings from sales slips. The geoduck catch data for 1976 to 1980 as reported in the catch statistics (Table 11) are incomplete because geoducks with dark coloured meat that were rejected by processors were not included as catch on the sales slips. The occurance of geoducks with dark meat is site specific and ranged from 0 to 75 percent in some catches. When vessels were delivering dark geoducks the processors requested that they move to another area.

This problem was reduced in 1981 with the introduction of a new regulation that requires that all harvested geoducks must be processed.

NUMBER OF VESSELS IN THE FISHERY

The number of boats participating in the geoduck fishery was summarized previously in Table 10. The number of vessels landing geoducks increased rapidly from five at the inception of the fishery in 1976, up to 72 vessels with landings in 1979 when a moratorium on new licences was issued.

Licences for 1981 were restricted to those fishermen who landed greater than 30,000 pounds in 1978 or 1979, including January 1 to March 31, 1980 depending on when the fisherman was first licenced. This action reduced the number of licences or licenced vessels with only minor catches.

The vessels not eligible for the 1981 fishery accounted for approximately 10 percent of the 1980 catch, but more significantly, the potential fleet size was reduced in half. This was considered an essential step towards developing an economically viable geoduck fishery.

VESSEL SIZE

The geoduck fishery has been conducted mainly by small vessels. However, since the development of the fishery off the west coast of Vancouver Island and future exploration of the central and north coast, fishermen have requested to upgrade the larger vessels for both safety and comfort.

The distribution of the size of vessels reporting landings in the geoduck fishery, 1978 to 1981, is outlined in Figure 6. Data were not available for vessels in 1976 and 1977. In addition, vessel length data was not available for 2 vessels in 1978, 12 vessels in 1979, 1 vessel in 1980 and 3 vessels in 1981.

Active vessel sizes have ranged from 5 m to 15.21 m. Vessels to 27 m were licenced but did not meet minimum landing requirements.

In 1978, most of the 27 vessels were less than 10 m, and only one was greater than 15 m.

More boats entered the fishery in 1979 and 1980, most of them being between 7 and 13 m long. In 1980, only one vessel was greater than 15 m.

A policy was introduced in 1980 which limited the transfer of geoduck permits to a vessel of equal or smaller size.

VESSEL LICENCE TYPES

A summary of the types of boat licences on vessels participating in the geoduck fishery is presented in Table 13. By 1981, no salmon "A" licences had geoduck privileges and the geoduck and horse clam fleet was composed mainly of category "C" licence vessels. These vessels also land sea urchins, sea cucumbers and other species for which there is not limited entry. Three vessels in 1980 (reduced to two in 1981) also had "E" licences and participated in the abalone fishery. In 1981, two vessels also fished for halibut under an "L" licence.

VESSEL FISHING DAYS

The distribution of effort, fishing days, in the geoduck fishery for 1978 to 1980 is presented in Figure 7. Each year, a number of licenced vessels did not fish for geoducks or horse clams (Table 10).

During the period 1978 to 1980, the highest efforts were 100 to 150 fishing days (Figure 7). Many of the boats with low efforts, less than 30 fishing days, were eliminated in 1981 by minimum landing requirements to retain the geoduck and horse clam licence. Data were not available for previous years.

VESSEL LANDINGS - DISTRIBUTION OF CATCH

The distribution of the annual geoduck harvest by individual boats for 1978 to 1980 is presented in Figure 7. There is a large range in individual vessel landings; in 1979 and 1980, 38 and 25 boats respectively landed less than 40,000 lb.

In 1978, 8 vessels landed 100,000 to 200,000 lb. and 4 vessels landed more than 200,000 lb. The vessels production improved in 1979 and 1980 respectively, when 15 and 11 vessels landed 100,000 to 200,000 lb. and 7 and 9 vessels landed more than 200,000 lb.

Geoduck licence holders that did not harvest more than 30,000 lb. in 1978 or 1979 (including January to March 31, 1980) were eliminated from the 1981 fishery. This may be reflected in the 1981 harvest statistics by a reduction in the number of boats with low landings.

VESSEL CATCH PER UNIT EFFORT (CPUE) - DAILY LANDINGS

Catch per unit effort (CPUE) is a commonly used term in fisheries, referring to the rate of harvest. Figure 9 presents the data in the units "pounds per vessel day", determined from sales slip data but other units commonly used for geoduck CPUE include pounds per diver minute, or pounds per diver hour.

Most vessels landed 1,000 to 3,000 lb./vessel day. A few landed up to and greater than 5,000 lb./vessel day. The landings per day would of course depend on the number of divers, working depths and concentrations of geoducks.

CPUE data is commonly used in fisheries management as an indicator of relative stock abundance; however, in the geoduck fishery there are many factors other than stock abundance which may cause dramatic changes in the CPUE. As an example, the geoduck vessel daily landings for 1978 to 1980 increased each year since the inception of the fishery (Figure 9). However, this does not necessarily mean that the abundance of geoducks is increasing. In fact, one would expect the opposite is likely occurring.

Changes in the vessel CPUE in the geoduck fishery could result from any of the following circumstances:

(1) An increase in the number of divers per boat.

(2) Improved efficiency of vessels and vessel operators in the fishery.

(3) An increase in the experience of divers.

(4) A trend to harvest in areas of higher geoduck density.

(5) The season of harvest, affecting working conditions and the number of geoduck "shows".

(6) Changes in the abundance of geoducks.

DIVER CATCH PER UNIT EFFORT

Most vessels have two or three divers and some as many as 4 divers per day. The number and duration (bottom time) of dives will vary depending on the number of divers. A geoduck diver may dive for 200 minutes, (3.3 hours) in a day to land a catch averaging 1,000 pounds but sometimes as high as 2,000 to 3,000 pounds. The diver may collect three or more geoducks a minute under good conditions, filling his tubular collection bag in 15 to 20 minutes. Figure 10 illustrates diver catch per unit as reported in harvest logs from 1978 to 1980.

The top five geoduck divers in 1978 dove 260 to 480 hours landing 80,000 to 140,000 pounds in a season. In 1979, it took fewer hours to land the same number of geoducks: 245 to 430 hours to land 100,000 to 145,000 pounds.

In 1980, because of quotas the season was shortened, top diver times were 300 to 350 hours but top diver landings were still 95,000 to 130,000 pounds. This increase in catch per unit effort may be due to several reasons, but it is likely due to diver experience and diving in areas of higher geoduck density.

Divers are paid 40 to 50 percent of the landed value, according to the number of geoducks they harvest times an average weight determined from the sales slip. Geoduck diving is an extremely demanding job, requiring many hours of diving under adverse conditions of cold water, heavy gear, currents, and poor visibility. There have been several deaths, cases of decompression sickness (or the "bends") and recent indications of bone necrosis.

A diver may stay in the fishery for three or four years but there is generally a large turnover every year: 44% in 1978 and 65% in 1979.

There are no data for diver participation prior to 1978. In 1978 there were records for 92 divers. This increased to 211 divers in 1979, 51 divers who fished in 1978 and 160 new divers.

In 1980 there were 236 divers; 72 divers from 1979, 37 from 1978 and 127 new divers.

GEODUCK CATCH BY DEPTH

There is an increase in the depth of harvest reported in catch logs from 1978 to 1980 (Table 14). From 1978 to 1980 there was an increase in the total catch reported from depths from 30 to 40 feet and depths greater than 40 feet. There are several reasons for this:

1) Experienced divers may dive at greater depths where they report densities are greater.

2) There has been an increase in the number of divers working from the boats. When there are two divers in the water, one may fish shallow while the other fishes in deeper water.

3) The reported depth intervals are often recorded for use in calculating the divers no-decompression limits according to U.S. Navy Diving Tables. A dive is recorded as the exact or next greatest depth in the table than the maximum depth descended during the dive. Accordingly the recorded depths are usually deeper than the true depth of the dive.

4) Divers may be reporting dives at high tide more often. Tidal ranges of 15 feet are not uncommon.

GEODUCK AVERAGE WEIGHT

Goodwin (1976) found that for Puget Sound geoducks, the greatest annual weight gain occurred between the third and seventh years and an average 10 year old geoduck weights 1200 g.

There are several problems when examining weights of geoducks reported on sales slips because of varying procedures. Weights on sales slips are often not "true weights" but have a percentage (often from 10 to 20 percent) deducted for water content. The time for delivery of the geoducks may be one to three days after harvest, and the water loss varies considerably.

Anderson (1971) estimated that the whole fresh animal contains approximately 28.1% water/sand, 17.4% shell, 12% viscera and 42.5% edible meat. Goodwin (1973) similarly reported that the average whole, fresh dug geoduck consists of about 56% meat. He defined meat as all portions of the clam minus the shell and water of the major body cavities. Goodwin (1978) allowed 2 to 10 minutes before weighing whole wet weight. The mantle "steak" (body meat, brisket or belly) comprises approximately 15 to 16% of the whole wet weight while the larger siphon or "neck" comprises approximately 2 to 25% of the whole wet weight.

The number of pieces (clams) for each diver is recorded on harvest log sheets. The average weight is calculated from the total weight recorded by the processor on the sales slip divided by the number of pieces recorded on the vessel logs. Average weights reported on log sheets have been determined from the total weight of landings in a day, week, or two week period.

Cox and Charman (1979) calculated average drained weights from geoducks cut in the anterior region of the mantle steak and placed with the cut facing down to allow excess water to drain for 15 minutes.

FISH INSPECTION AND PRODUCT QUALITY

PROCESSING REQUIREMENTS

The processing of geoducks is monitored by the Fish Inspection Division, Field Services Branch of the Department of Fisheries and Oceans. A schematic diagram of the steps involved in the processing of geoducks is shown in Figure 11. The edible parts of the geoducks are the siphon and body meat. The current demand is for the white or light coloured siphon meat, while only a limited market exists for the body meat. As more companies became familiar with the processing of geoducks, regulations were gradually introduced to restrict the export of unprocessed geoducks. Regulations were introduced in 1981 to require the siphon meat to be processed in Canada and to prohibit the dumping of body meat and the dark coloured geoducks.

Whole geoducks are landed at the plant and weighed. Some may be selected for live export by air; based on freshness, size, colour and intact shells. The export of live geoducks by truck was prohibited in July, 1979, to protect the developing Canadian geoduck processing industry.

Before these regulations came into effect, some geoducks were only partially processed in 1980 and exported by truck to Washington State for final processing. Partial processing included removing the shells and gut and washing.

Full processing includes an initial blanching, then removing the shells, gut and skin from the siphon. The siphon meat is cleaned and frozen for export. The body meat is frozen or processed into smoked, chopped, canned or other products. Because of limited markets, some dumping of the body meat has occurred. This was prohibited in 1981 by regulation but continues illegally.

PARALYTIC SHELLFISH POISON (PSP) IN GEODUCKS

The source of paralytic shellfish poison (PSP) is a microscopic one-celled organism *Gonyaulax catenalla*. It contains a poison which is fatal to humans, acting on the nervous system, but is harmless to molluscs. As bivalve molluscs (clams, oysters, mussels, etc) filter water for food and respiration they may collect *Gonyaulax* and build up toxin in their tissues. (Quayle 1966).

The standard for acceptable PSP content is 80 µg/100 grams of shellfish meat. Geoducks, being filter feeding animals, will accumulate PSP toxin. In 1977, PSP levels up to 2700 µg/100 g of meat were detected in geoduck samples from Hayden Passage, Area 24. However, a 1979 survey has confirmed earlier findings that the PSP toxin in geoducks is primarily concentrated in the gut and not in the edible meat. With the removal of the gut during processing, the potential danger of consuming toxic geoducks is reduced. Accordingly, the harvesting of geoducks from PSP closed areas is allowed under licence provided the geoducks are processed and inspected in Canada.

For live shipments of geoducks from PSP closed areas, the companies are required to make prior arrangements with the Federal Inspection Division (Fisheries and Oceans) for the testing and clearance for export of those geoducks.

SANITARY CLOSURES

Some waters adjacent to populated areas are closed to shellfish harvesting because of sewage pollution. These closures are determined specifically for oysters and intertidal clams, but also include geoducks within the boundaries of the closed areas. Geoduck harvesting was permitted in one closed area, Gillies Bay, in 1979 and 1980, under the condition that all catches be analysed for sewage contamination. This practice was discontinued in 1980 because of difficulties in proper monitoring of catches from contaminated areas.

MARKET AND ECONOMIC CONSIDERATIONS

LANDED VALUES

As discussed earlier, the values of the geoducks landed in British Columbia in the years 1977 to 1980 increased from $74 thousand to $2.26 million (Table 9). In that period there was a steady rise in the average price paid to fishermen from 17 to 37 cents per pound, an average annual increase of 32 percent.

GEODUCK EXPORTS

Japan is the major customer for geoduck exports, receiving approximately 88 percent by value of the British Columbia exports (Table 15). The remainder goes to the United States and Hong Kong. The Japanese received mainly frozen siphon meat, the Americans imported mostly live geoducks and fresh shucked meats, while Hong Kong imports live geoducks and frozen siphon meat.

There has been a trend since 1978 toward more highly processed exports (Table 16). The shift has been from live or fresh shucked export toward more highly processed products, mainly frozen neck meat. This transition to highly processed exports should be enhanced in the future with a regulation stating that the geoduck siphon meat must be fully processed in Canada prior to export. This will ensure that the maximum economic benefits are obtained by the British Columbia fishing industry.

ACKNOWLEDGEMENTS

Sing Liem, Shellfish Co-ordinator, Fish Inspection Division provided the information regarding fish inspection and product quality.

Paul Breen and Rod Carmichael of the Fisheries Research Branch, Pacific Biological Station assisted in the data analysis of harvest logs.

The authors thank Paul Breen for critically reviewing this manuscript.

Figure 1 was taken by Victor Anysimiw and figures 5 to 10 were prepared by Laurie Burke.

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TABLE 1. Preliminary commercial geoduck standing stock estimates[1], by Statistical Areas

Fisheries Statistical Areas	Geoducks (lb.)	Geoducks (metric tons)
Areas 11, 12	400,000	181
Area 13	3,036,000	1,377
Area 14	20,020,000	9,081
Area 15	2,633,000	1,194
Area 16	6,093,000	2,764
Areas 17, 18	20,978,000	9,516
Area 19	6,207,000	2,734
Areas 20, 21, 23	34,938,000	15,848
Area 24	84,850,000	38,488
Areas 25, 26, 27	75,000,000	34,020
	254,155,000 lb.	115,203 t

[1]Interpretation of estimates by the Provincial Marine Resources Branch (Cox and Charman, 1979 and Cox, unpublished data)

TABLE 2. Monthly Geoduck Landings for 1976 (from sales slip records in 1000's of pounds)

Month	Landings by Statistical Area (1000's lb.)			Monthly Totals
	14	17	19	
June	no landings to June			
July			2	2
Aug.			11	11
Sep.		2	19	21
Oct.		4	25	29
Nov.	16	5	1	22
Dec.	5	7		12
Area Totals:	21	18	58	97

TABLE 3. Monthly Geoduck Landings for 1977 (from sales slip records in 1000's of pounds).

	Landings by Statistical Areas (1000's lb.)						
Month	13	14	15	17	18	24	Monthly Totals
Jan.	14			30			44
Feb.	13			37			50
Mar.	4		5	22			31
Apr.			9	46			55
May			28	35			63
Jun.			55	37			92
Jul.		10	63	85	4		162
Aug.			7	5			12
Sep.		10	2				12
Oct.				4			4
Nov.							
Dec.			1		2	13	16
Area Totals:	31	20	170	301	6	13	541

TABLE 4. Monthly Geoduck Landings for 1978 (from sales slip records in 1000's of pounds).

Month	Landings by Statistical Areas (1000's lb.)												Monthly Totals
	13	14	15	16	17	18	19	20	21	23	24	25	
Jan.		14	11								20	4	49
Feb.		26	9								22		57
Mar.		47	26				10		4		32		119
Apr.		61	23		3	3	23		2		112		227
May		30	55				7				41		133
Jun.		60	71		4		63				104		302
Jul.		111	60	1	7	5	94			4	93		375
Aug.		92	101		2	12	84				60		351
Sep.	8	38	127			5	18				35		231
Oct.		34	188	7	2	5					2		238
Nov.	10	38	40	1	19	9							117
Dec.		24			15	2		1					42
Area Totals	18	575	711	9	52	41	299	1	6	4	521	4	2241

TABLE 5. Summary of 1979 Geoduck Quotas, Landings and Closure Dates by Management Units

Management Units Statistical Areas	1979 Quotas (1000's lb.)	Landings (1000's lb.)	Date Areas Closed
Areas 1 to 10	3,500	0	December 31, 1979
Areas 11 to 27	4,500	4,781	Areas 13 to 19 and 24 were closed September 20, 1979
		649	Areas 11, 12, 20, 21, 23 and 25 to 27 remained open to December 31, 1979
Coastwide Quota:	8,000	Total Landings: 5,430	

TABLE 6. Monthly Geoduck Landings for 1979 (from sales slip records in 1000's of pounds).

Month	Landings by Statistical Areas (1000's lb)															Monthly Totals
	12	13	14	15	16	17	18	19	20	21	23	24	25	26	27	
Jan.				11		28		1				18				58
Feb.		1	2	37	3	40						5				88
Mar.	2	49	20	23	2	75		4				111			3	289
Apr.		35	63	40	91	94	6	36				312				677
May		43	45	53	114	58		53				317				683
Jun.		70	100	79	36	45		71				343				744
Jul.		35	110	132	26	51		125				409				888
Aug.	17	68	147	141	36	33		47			18	387	6			900
Sep.	22	52	118	63	18	37		15			90	190	3			608
Oct.	11			1							107		39	9	17	184
Nov.											93		86	39		218
Dec.	1		4								28	2	58			93
Area Totals	53	353	609	580	326	461	6	352			336	2094	192	48	20	5430

TABLE 7. Summary of 1980 Geoduck Quotas, Landings, and Closure Dates by Management Units

Management Units Statistical Areas	1980 Quotas (1000's lb.)	Landings (1000's lb.)	Date Area Closed
North Coast			
Area 2E		69	December 31, 1980
Area 4		8	December 31, 1980
Area 9	3,500	61	December 31, 1980
Area 10	(for areas 1-10)	12	December 31, 1980
North Coast Quota	3,500	Landings 150	
South Coast			
Areas 11, 12, 13	200	214	June 29, 1980
Area 14	400	475	March 29, 1980
Areas 15 and 16	500	38 664	May 16, 1980 May 16, 1980
Areas 17 and 18	400	497 74	August 5, 1980 August 5, 1980
Area 19	200	202	July 18, 1980
Areas 20, 21, and 23	500	11 0 635	August 31, 1980 August 31, 1980 August 31, 1980
Area 24	1,700	1,852	February 29[1] and May 21[2], 1980
Areas 25, 26, and 27	600	710 667 0	June 16, 1980 August 31, 1980 August 31, 1980
South Coast Quota	4,500	Total Landings 6,189	

[1]Some heavily harvested beds closed.
[2]All of area 24 closed.

TABLE 8. Monthly Geoduck Landings for 1980 (from sales slip records in 1000's of pounds).

	Landings by Statistical Area (1000's lb.)																
	North Coast				South Coast												
Month	2E	4	9	10	12	13	14	15	16	17	18	19	20	23	24	25	26	Monthly Totals
Jan.							73	21		3					17	25		139
Feb.						1	146	16	31	12		3			222			431
Mar.						1	218		98	39	11	18			526	9		920
Apr.						10	28		334	104	39	2			646	32		1,195
May						83	3		201	51	18	41		48	441	35		921
Jun.						109				90	3	100	11	60		609	22	1,004
Jul.		8				10				154	3	38		164			230	607
Aug.	24							1		44				363			369	801
Sep.	29		39	4													46	118
Oct.	16		20	8														44
Nov.			2				7											9
Dec.																		0
Area Totals	69	8	61	12		214	475	38	664	497	74	202	11	635	1852	710	667	

North Coast Total: 150 South Coast Total: 6,039 Coast Wide Total: 6,189

TABLE 9. Landed Values of Geoducks, 1977 to 1980 (from sales slip records).

Year	Total Landings lb.	kg	Value ($)	Mean Price Per lb.	Per kg	Range $/lb.	$/kg
1977	540,898	245,351	89,393.83	$ 0.17	$ 0.36		
1978	2,239,950	1,016,041	569,288.83	0.25	0.56	0.15 - 0.35	0.33 - 0.77
1979	5,429,886	2,462,996	1,669,447.02	0.31	0.68	0.13 - 0.40	0.29 - 0.88
1980	6,160,903	2,794,586	2,298,655.19	0.37	0.82	0.30 - 0.48	0.66 - 1.06

TABLE 10. Summary of licensing regulations and the number of vessels participating in the Geoduck Clam Fishery from 1976 to 1981.

Year	Regulation	No. of Permits or Licences	No. of Vessels with Landings
1976	Special geoduck harvesting permits issued with exclusive harvesting rights for areas in the Strait of Georgia.	7	5
1977	Licences were required on July 1, 1977, when the geoduck fishery was included in the Pacific Shellfish Regulations. Exclusive harvesting rights were not given with licences. Permits were required to fish in areas closed to shellfish harvesting because of the threat of Paralytic Shellfish Poisoning (P.S.P.). Harvest logs were introduced.	30	14
1978	Licences were issued pursuant to Pacific Shellfish Regulations. Special permits were issued to harvest on the West Coast of Vancouver Island in a P.S.P. closed area.	54	27
1979	A moratorium on new geoduck licences effected June 13, 1979. Licences were not transferable. Licences were expanded to include horseclams. A proposal to establish a Category 'G' vessel licence was initiated in November, 1979. Fisheries announced that minimum landing of 30,000 lbs. would be required for 1980 licence. Quotas of 3.5 million pounds for the North Coast and 4.5 million pounds for the South Coast were introduced.	101	72
1980	Separate licences were required for harvesting from the North and South Coast Districts. Quotas increased to 5 million pounds for the South Coast and 3.5 million pounds for the North Coast.	95	63
1981	Licences were issued only to registered owners of vessels that had landings greater than 30,000 in 1978 or 1979.	52[1]	

[1] In addition, there are licences that will be issued if an appropriate boat is acquired, and there are a number of appeals pending.

TABLE 11. Summary of Geoduck landings by statistical areas, 1976 - 1980. (From sales slip records in 1,000's pounds)

	Landings by Statistical Area																		
Year	12	13	14	15	16	17	18	19	20	21	23	24	25	26	27	2E	4	9	10	TOTAL
1976																				97
1977			21			18		58												541
1978		31	20	170		301	6					13								2,240*
1979	53	18	575	711	9	52	41	299	1	6	4	521	4							5,430
1980		353	609	580	326	461	6	352			336	2094	192	48	20					6,161
		214	463	38	657	487	75	202	11		636	1854	707	667		69	8	61	12	
Area Totals	53	616	1688	1499	992	1319	128	911	12	6	976	4482	903	715	20	69	8	61	12	14,470

*Total landings by area rounded off so that they actually total 2,241.

TABLE 12. Percentage of the total Geoduck landings from each statistical area for the years 1976 - 1980. (From sales slip records).

	Strait of Georgia								West Coast of Vancouver Island								North Coast				
Year	12	13	14	15	16	17	18	19	Sub Total	20	21	23	24	25	26	27	Sub Total	2E	4	9	10	Sub Total
1976			21.6			18.6		59.8	100.								0.0					
1977		5.7	3.7	31.4		55.6	1.1		97.5				2.4				2.4					
1978		0.8	25.7	31.7	0.4	2.3	1.8	13.3	76.0	0.1	0.3	0.2	23.2	0.2			24.0					
1979	1.0	6.5	11.2	10.7	6.0	8.5	0.1	6.5	50.5			6.2	38.6	3.5	0.9	0.4	49.6					
1980		3.5	7.7	0.6	10.7	8.0	1.2	3.3	35.0	0.2		10.3	29.9	11.5	10.8		62.7	1.1	0.1	1.0	0.2	2.4

TABLE 13. Types of vessel licences on boats participating in the 1978 - 1981 geoduck fishery.

Vessel Licence Type	1978*	1979[1]	1980	1981[2]
A	8	5	3	0
C	19	52	51	43
E	0	3	3	2
H	1	1	1	2
L	0	4	6	2

[1]1978, 1979 data incomplete due to vessel transfers, and vessels entering or leaving the fishery.

[2]1981 data incomplete as some eligible licencees do not have vessels.

TABLE 14. Geoduck harvest by depth interval for the years 1978 to 1980 (in percent of the annual harvest).

Depth (feet)	1978	1979	1980
10 - 19	0	.1	2
20 - 29	23	8	6
30 - 39	50	57	40
40 - 49	23	31	45
50 - 59	4	4	7
60	0.1	0.1	0.3

TABLE 15. Geoduck exports by country and product type for 1980[1].

	JAPAN		UNITED STATES		HONG KONG		TOTALS	
	Quant. lb.	Value ($)	Quant. lb.	Value ($)	Quant. lb.	Value ($)	Quant. lb.	Value ($)
Frozen Neck Meat	712,783	2,271,274	11,269	33,609	20,587	67,966	744,639	2,372,849
Frozen Body Meat	4,328	4,534	31,283	17,186	2,200	1,938	37,811	23,658
Fresh Shucked Meat			104,234	84,105			104,234	84,105
Live			85,970	74,645	27,895	46,899	113,865	121,544
Frozen Meat	26,020	60,285					26,020	60,285
Whole Frozen			3,138	2,740			3,138	2,740
Frozen Steaks			3,444	10,022			3,444	10,022
Totals	743,131	2,336,093	239,338	222,307	50,682	116,803	1,033,151	2,675,203
% of Total Quantity or Value	71.9	87.3	23.2	8.3	4.9	4.4		

[1]Data source - Canada Export Declarations from British Columbia - does not include exports from other Canadian points, e.g., shipping from Toronto.

(Quantities are in pounds and values in Canadian dollars).

TABLE 16. Geoduck exports by product type. 1978 - 1980[1]

Product Type	Quantity		Export Share[4]		Price[2]	Export Value[2]	
	1978 (lb.)	1980 (lb.)	1978 (%)	1980 (%)	1980 ($/lb.)	1978[3] ($)	1980 ($)
Frozen Neck Meat	39,582	754,474	9.8	72.3	3.25	128,642	2,452,041
Body Meat	23,365	37,811	5.8	3.6	.63	14,720	23,821
Fresh Shucked Meat	173,263	104,234	42.8	10.0	.80	138,610	83,387
Live	132,322	113,865	32.7	10.9	.95	125,706	108,172
Whole Frozen	22,960	3,138	5.7	.3	.87	19,975	2,730
Frozen Meat	12,952	29,464	3.2	2.8	2.39	30,955	70,419
Total	404,444	1,042,986				458,608	2,740,570

[1]Data source - Canadian Export Declarations from British Columbia; does not include exports from other Canadian points e.g., shipping from Toronto.

[2]In Canadian dollars.

[3]1978 production valued at 1980 prices.

[4]Percent share of total weight of exports - these may not total to 100 due to rounding off.

Figure 1. Geoduck Clams

Figure 2. Geoduck Clam Show

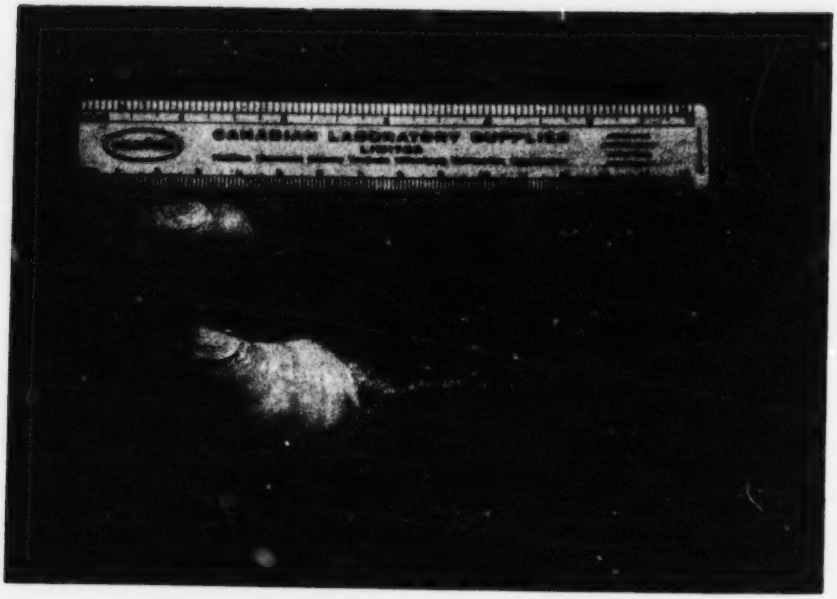

Figure 3. Geoduck Shells

Figure 4. Geoduck diver underwater

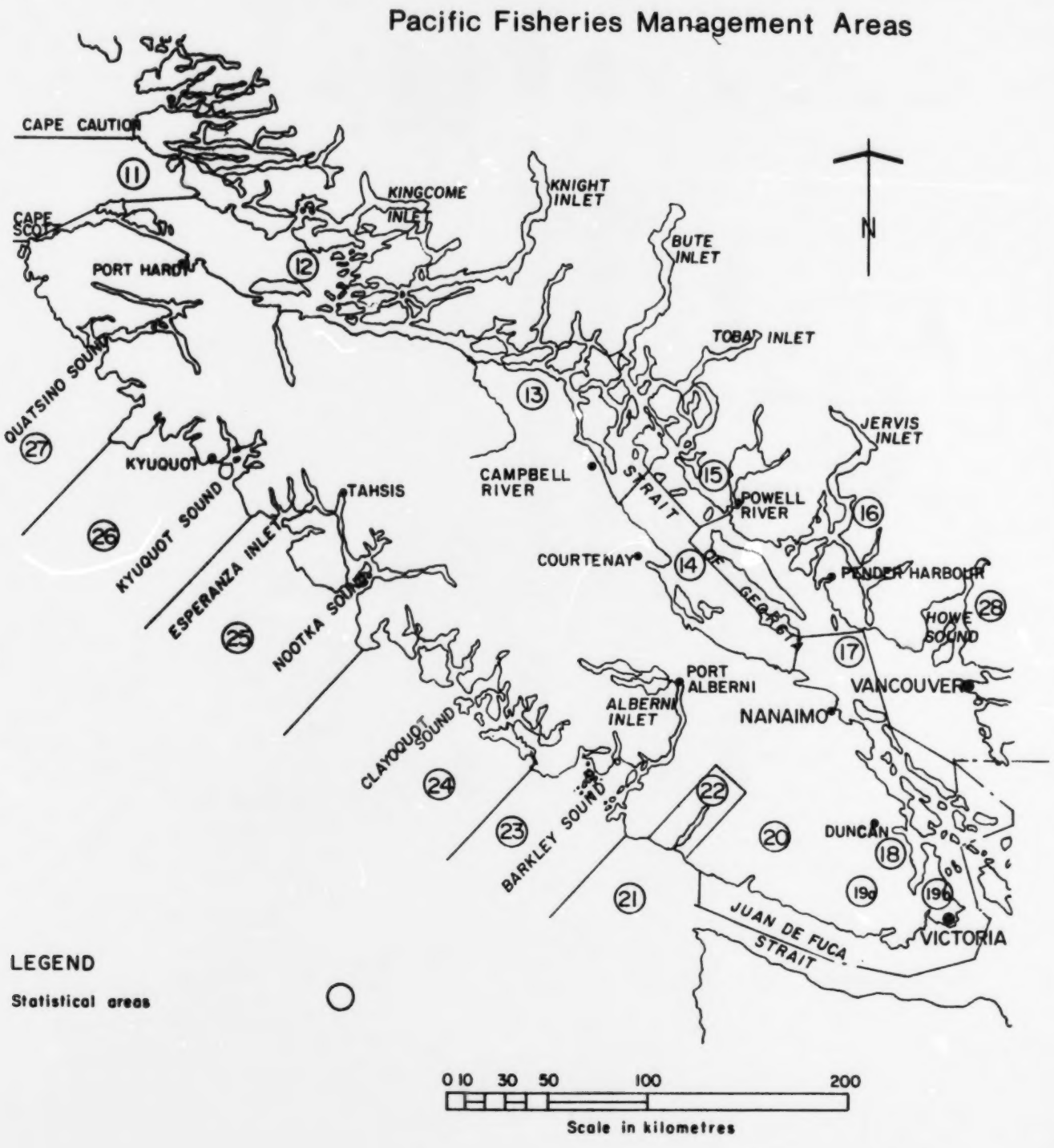

Figure 5(a). Department of Fisheries and Oceans Statistical Area Map - South Coast

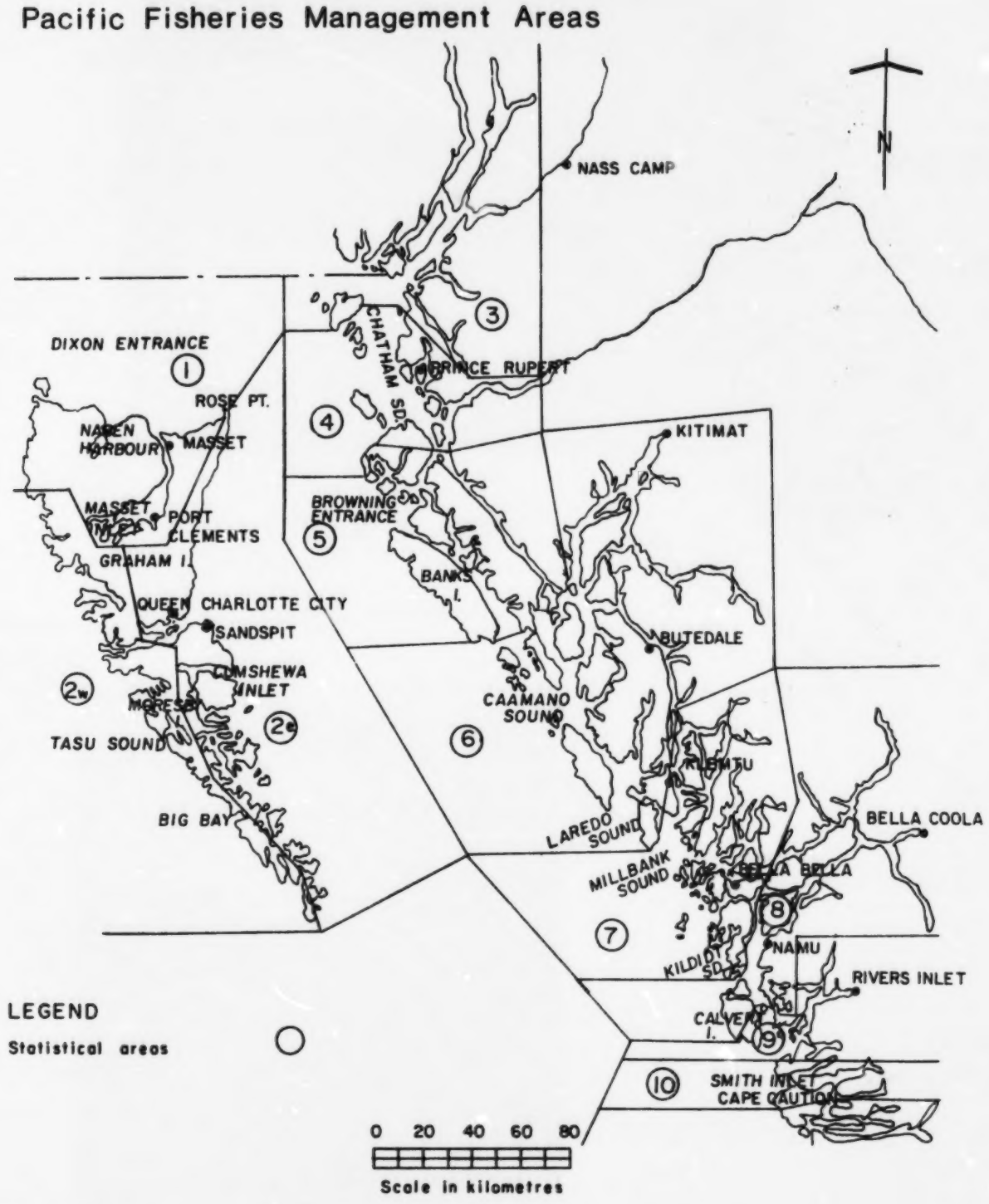

Figure 5(b). Department of Fisheries and Oceans Statistical Area Map - North Coast

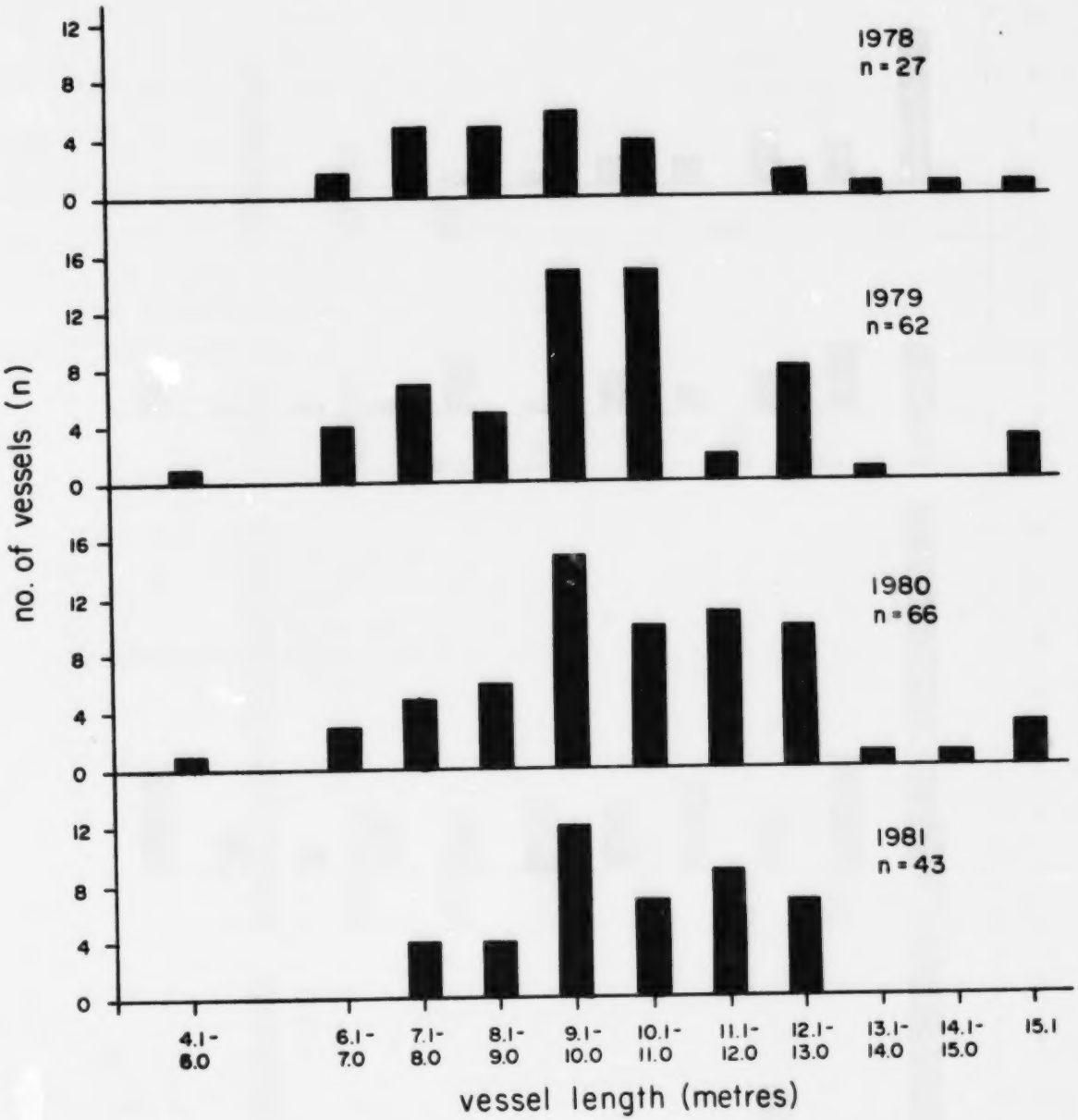

Fig.6. Size of vessels in geoduck fishery , 1978-1981.

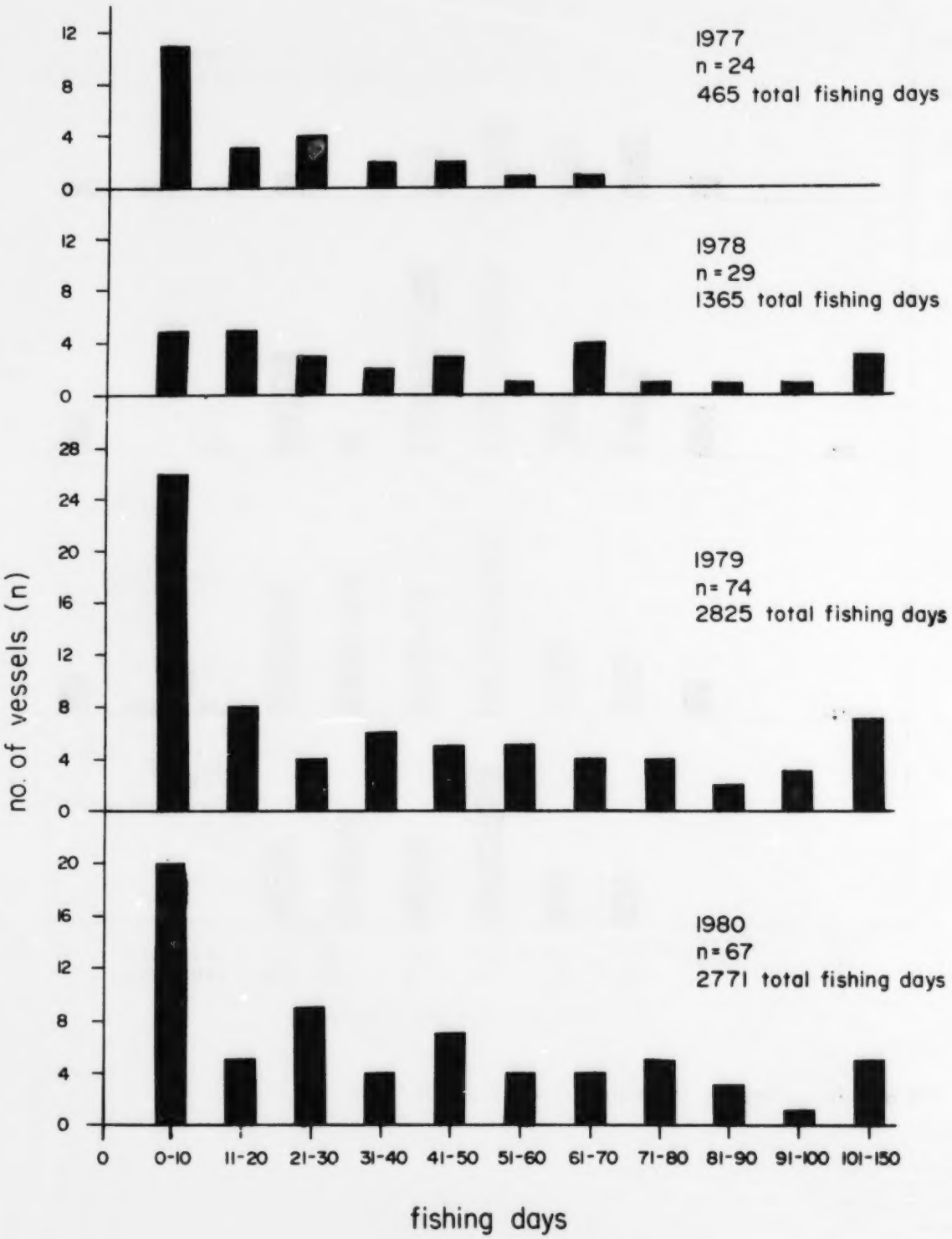

Fig. 7. Distribution of vessel effort in the geoduck fishery, 1977 - 1980.

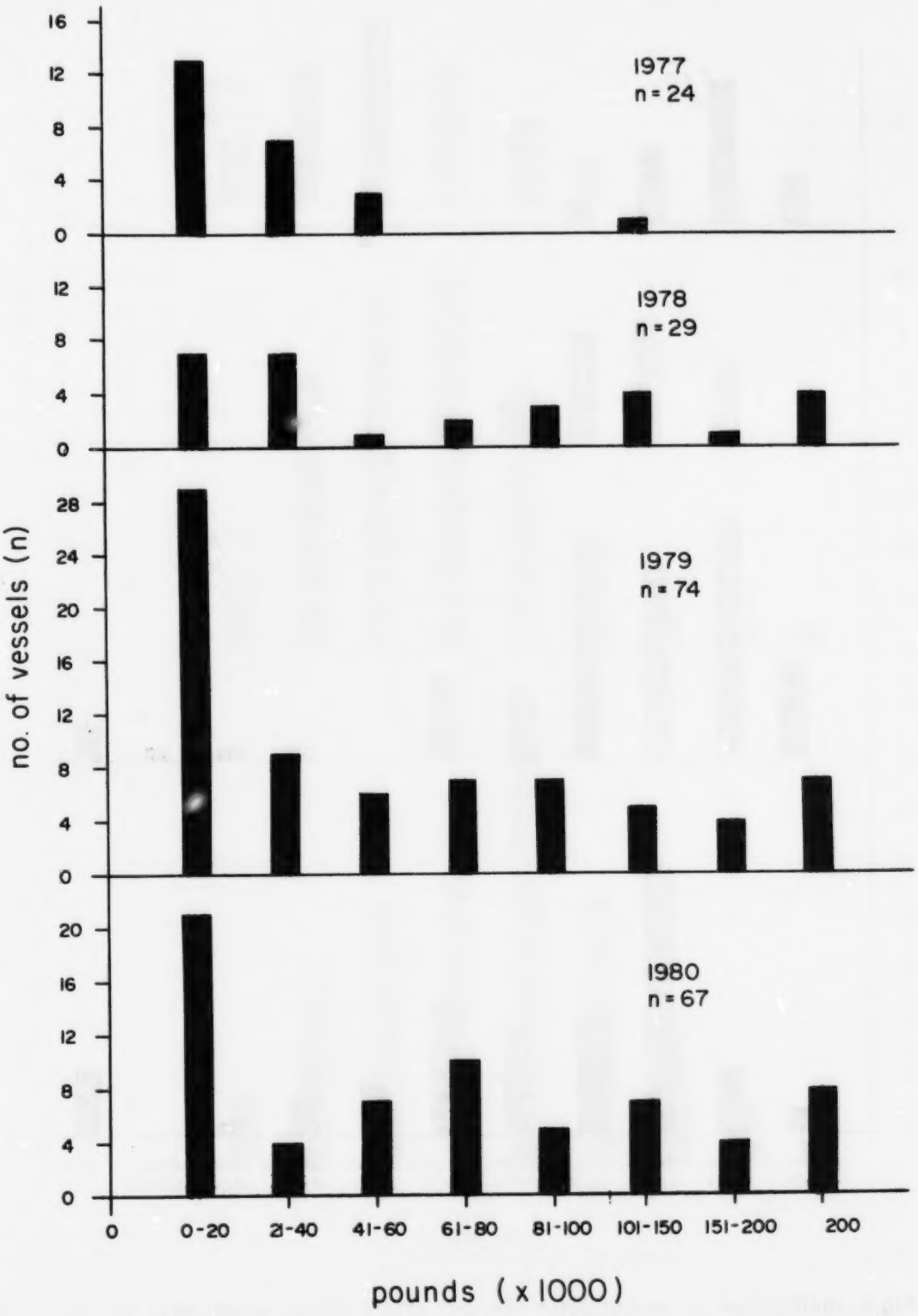

Fig. 8. Distribution of annual vessel catches of geoducks, 1977 - 1980.

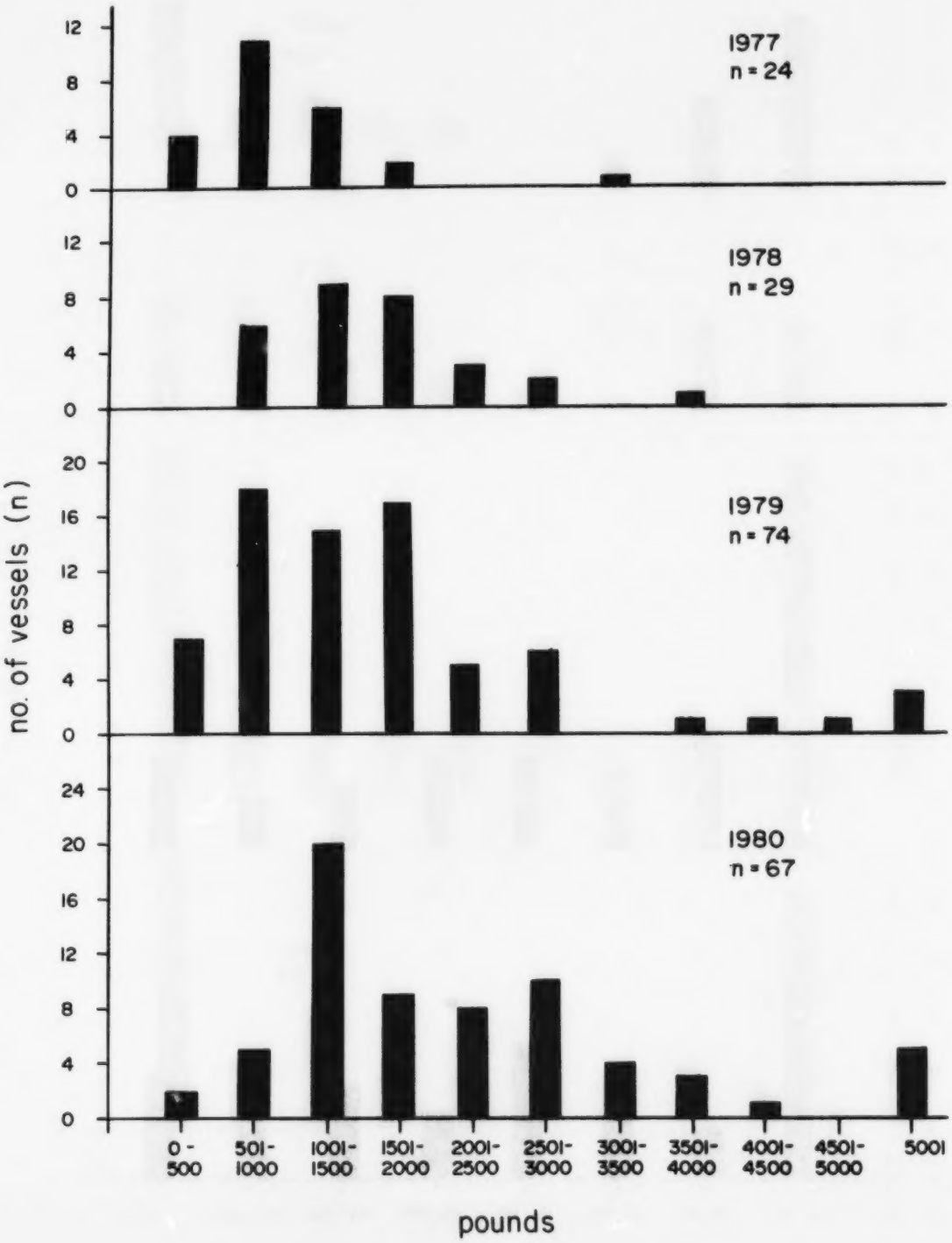

Fig.9. Distribution of vessel catch per unit effort (lb.per vessel day) for 1977 - 1980 (from sales slip data).

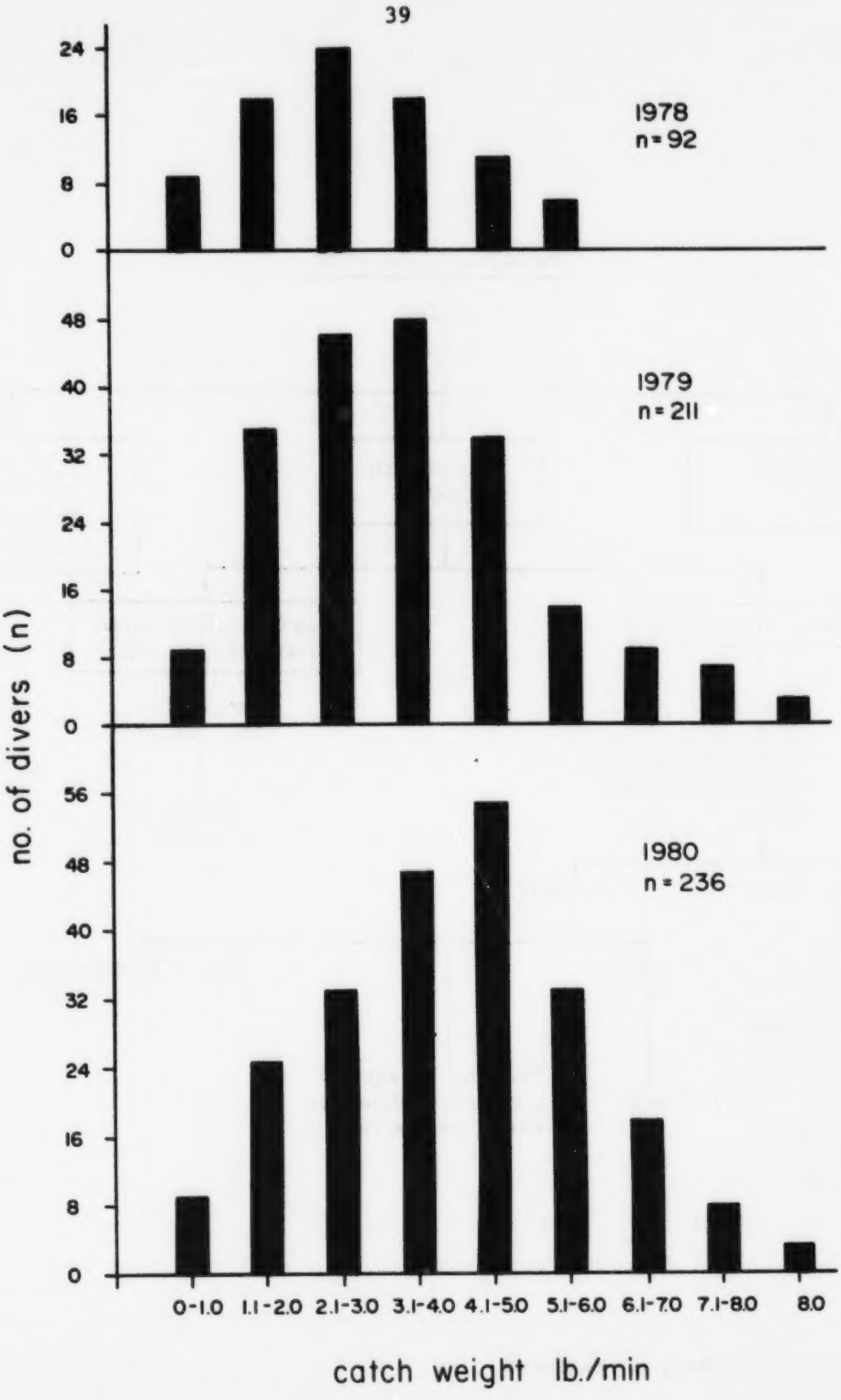

Fig.10. Diver catch per unit effort (lb./diver min), 1978-1980. (from harvest log data).

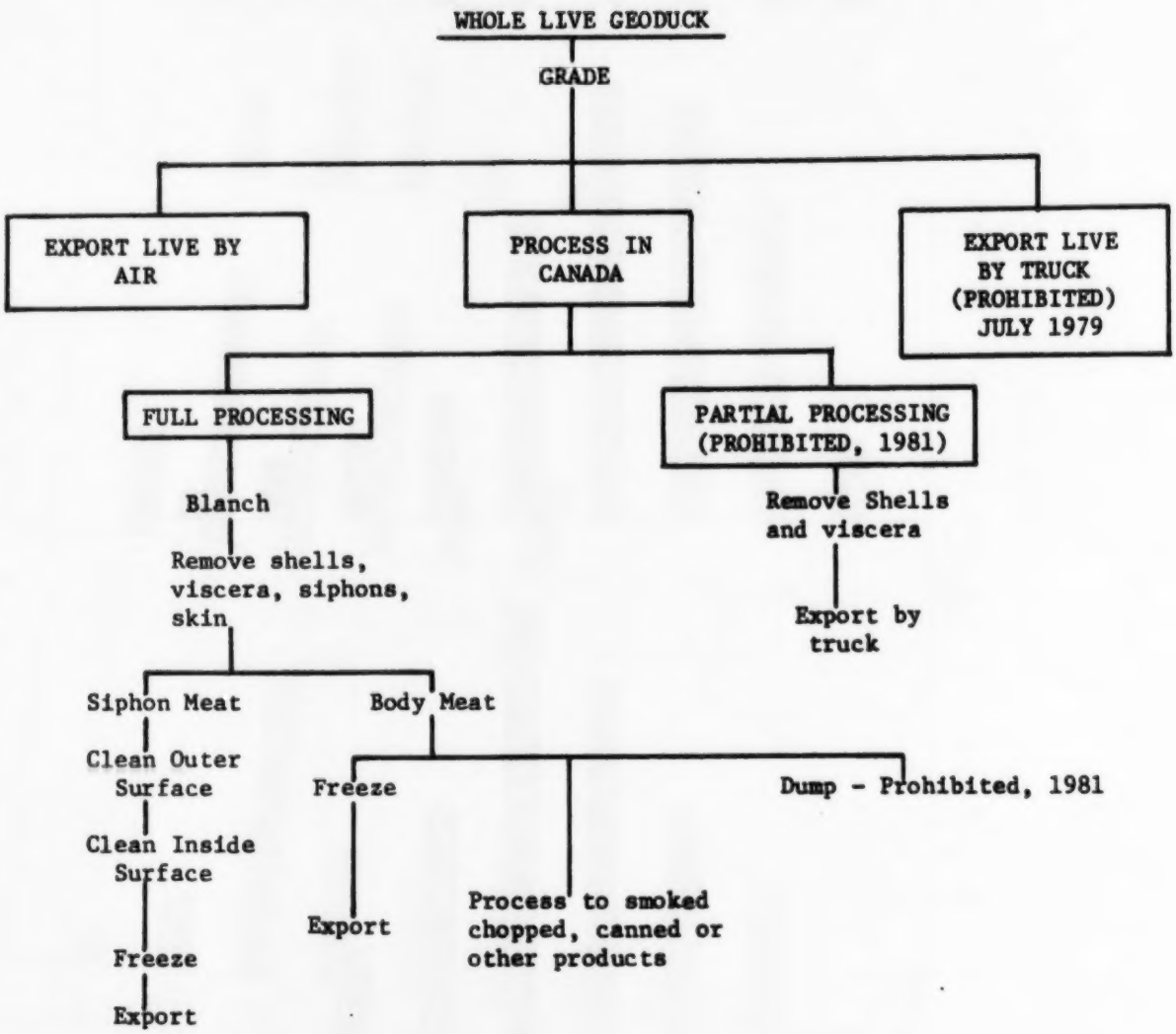

FIGURE 11: Processing of geoducks

POOR

QUALITY

ORIGINAL